(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 February 2002 (14.02.2002)

PCT

(10) International Publication Number
WO 02/13265 A2

(51) International Patent Classification[7]: H01L 23/40

(21) International Application Number: PCT/IB01/01585

(22) International Filing Date: 18 July 2001 (18.07.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/632,542 4 August 2000 (04.08.2000) US

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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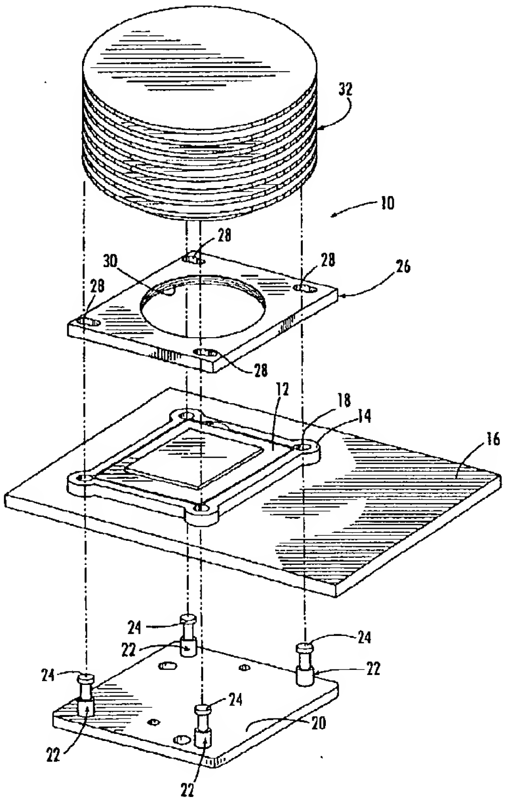
(54) Title: HEAT SINK ASSEMBLY WITH EVENLY DISTRIBUTED COMPRESSION FORCE



(57) Abstract: A heat sink assembly (10) for removing heat from an electronic device (12) is disclosed. A socket (14) is mounted to a printed circuit board (16) that has a top surface and a bottom surface and holes (18) formed therethrough. A heat generating device (12) is installed in the socket (14). Alignment pins (22) of a backing plate (20) are installed through the holes (18) in the circuit board (16). A clasp plate (26), having slits, grasps the alignment pins (22). The clasp plate (26) further includes a female threaded bore (30) which is positioned over the heat generating device (12). A heat sink member (32), with heat dissipating members (36) and a male threaded shank (34) with a bottom contact surface is threaded into the female threaded bore (30) so that the bottom contact surface of the threaded shank (34) is maintained in flush thermal and tensioned communication with the heat generating surface of the heat generating device (12).

06/01/2001

WO 02/13265 A2

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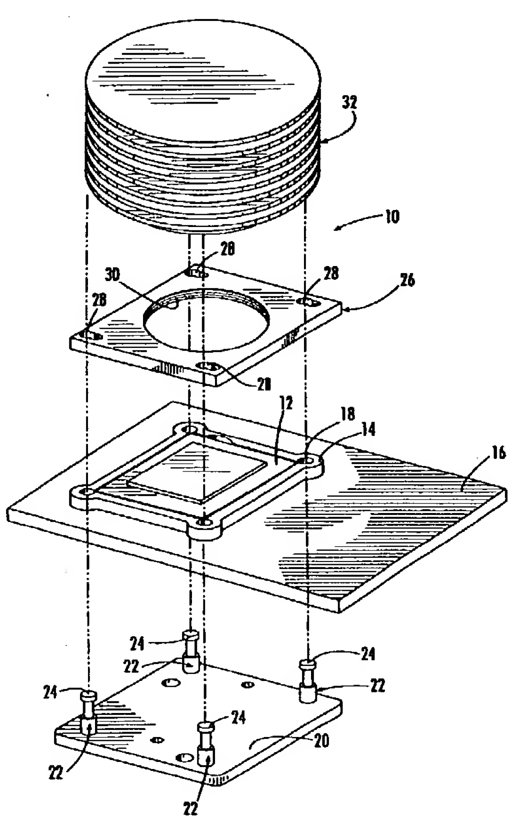
(54) Title: HEAT SINK ASSEMBLY WITH EVENLY DISTRIBUTED COMPRESSION FORCE



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WO 02/13265 A2

Published:

— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

HEAT SINK ASSEMBLY WITH EVENLY DISTRIBUTED COMPRESSION FORCE

BACKGROUND OF THE INVENTION

The present invention relates generally to electronic solid state and integrated circuit devices. More specifically, the present invention relates to apparatuses for dissipating heat generated by such devices.

In the electronics and computer industries, it has been well known to employ various types of electronic device packages and integrated circuit chips, such as the PENTIUM central processing unit chip (CPU) manufactured by Intel Corporation and RAM (random access memory) chips. These integrated circuit chips have a pin grid array (PGA) package and are typically installed into a socket which is soldered to a computer circuit board. These integrated circuit devices, particularly the CPU microprocessor chips, generate a great deal of heat during operation which must be removed to prevent adverse effects on operation of the system into which the device is installed. For example, a PENTIUM microprocessor, containing millions of transistors, is highly susceptible to overheating which could damage or destroy the microprocessor device itself or other components proximal to the microprocessor.

In addition to the PENTIUM microprocessor discussed above, there are many other types of semiconductor device packages which are commonly used in computer equipment, for example. Recently, various types of surface mount packages, such as BGA (ball grid array), LGA (land grid array) and CGA (column grid array) type semiconductor packages have become increasingly popular as the semiconductor package of choice for computers. For example, many microprocessors manufactured by the Motorola Corporation, for use in Apple Corporation computers, employ BGA-type packages. Unlike a PENTIUM microprocessor with a PGA package, which has pins to be installed into a receiving socket, BGA, LGA and CGA semiconductor packages include an array of electrical contacts on their bottom surfaces to engage directly with an array of receiving electrical contacts on a circuit board, socket or the like. These semiconductor device packages have, in the past, been soldered directly to a circuit board or socket. However, such direct soldering makes replacement and/or upgrade of the semiconductor device package more difficult because it must be unsoldered from the board or socket for such replacement or upgrade.

To address the foregoing concerns, various sockets are being provided to receive, in temporary fashion, a BGA, LGA, CGA or similar surface mount semiconductor device package. In the event replacement or upgrade is required, the semiconductor package is simply removed from the socket and replaced with the new package. However, there are various concerns relating to the use of such BGA, LGA or CGA socket. For example, since no soldering is carried out in these new socket configurations, the solder balls of a BGA package and the contacts of an LGA and CGA must be maintained in electrical communication with the corresponding contact array on the socket. As a result, a minimum amount of pressure or force must be maintained on the semiconductor device package to maintain the electrical contact with the socket. It is not uncommon for the required minimum pressure to be in the vicinity of 50 psi (pounds per square inch) to maintain the electrical connection of the device package to the socket into which it is installed. If this pressure is not maintained, or is not consistent over the surface of the package, the electrical connection will fail.

Various efforts have been made to simply clamp the semiconductor device package, such as a BGA, LGA or CGA, to its corresponding socket by a top planar member with a series of screw fastening members sufficiently secured to attain the desired psi pressure on the package. However, in these prior art devices, it is very difficult to adjust and maintain a constant and even pressure across the entire device to be cooled. Frequently, a separate clamping and heat sink member must be used.

In similar fashion to the PENTIUM-type semiconductor devices discussed above, the BGA, LGA, CGA and related device packages also suffer from excessive generation of heat. If such heat is not properly dissipated, the chip will eventually fail. As a result, efforts have been made to supply a heat dissipating member, such as a heat sink, into thermal communication with the silicon portion of the semiconductor device package, such as a BGA, LGA or CGA chip. As a result of the competing needs for heat dissipation and pressure to maintain the socket connection, problems arise. In particular, simple clamping of a heat sink member to the top portion of a BGA socket must be maintained at a pressure sufficient to maintain the electrical interconnections to the socket and the thermal communication between the heat sink member and the heat generating device to be cooled.

In view of the foregoing, there is a demand for a heat sink assembly which can simultaneously provide the requisite tensioned

clamping for maintaining a semiconductor device package in electrical interconnection with its corresponding socket while simultaneously providing a heat sink member in flush thermal communication with the for proper thermal dissipation. In addition, there is a demand for a heat sink assembly that can provide custom adjustment of the pressure of a heat sink applied to the heat generating device while to simultaneously maintain the heat generating device in electrical communication with its socket and thermal communication with the heat sink member.

SUMMARY OF THE INVENTION

The present invention preserves the advantages of prior art heat sink assemblies for integrated circuit devices, such as microprocessors. In addition, it provides new advantages not found in currently available assemblies and overcomes many disadvantages of such currently available assemblies.

The invention is generally directed to the novel and unique heat sink assembly with particular application in cooling microprocessor integrated circuit devices, particularly devices installed in a socket on a circuit board. The heat sink assembly of the present invention enables the simple, easy and inexpensive assembly, use and maintenance of a heat sink assembly while realizing superior heat dissipation.

A heat sink assembly for removing heat from an electronic device is disclosed. A socket is mounted to a printed circuit board that has a top surface and a bottom surface and holes formed therethrough. A heat generating device is installed in the socket. Alignment pins of a backing plate are installed through the holes in the circuit board. A clasp plate, having slits, grasps the alignment pins. The clasp plate further includes a female threaded bore which is positioned over the heat generating device. A heat sink member, with heat dissipating members and a male threaded shank with a bottom contact surface is threaded into the female threaded bore so that the bottom contact surface of the threaded shank is maintained in flush thermal and tensioned communication with the heat generating surface of the heat generating device.

In operation, the alignment pins are routed through corresponding holes in the circuit board from the back of the circuit board to the front. The clasp plate is then installed by aligning the slits on the clasp plate with the heads of the alignment pins. The clasp plate is slid horizontally so that the heads engage in locking fashion with the slits of the clasp plate. The heat sink member is installed by threading the male threaded

shank into the female threaded bore of the clasp member. Upon threading, the bottom contact surface of the male threaded shank of the heat sink member will be in flush thermal communication with the top heat generating surface of the heat generating device. Simultaneously, the thermal communication and physical clamping the heat sink assembly to the circuit board will be achieved.

It is therefore an object of the present invention to provide a heat sink assembly which can accommodate a wide array of semiconductor device packages.

It is an object of the present invention to provide a heat sink assembly that can accommodate a semiconductor device mounted on a processor card.

It is also an object of the present invention to provide a heat sink assembly that can accommodate a semiconductor device mounted in a socket on a circuit board.

It is a further object of the present invention to provide a heat sink assembly that can accommodate a semiconductor device without attaching to the device itself or the socket into which it is installed.

Another object of the present invention is to provide a heat sink assembly that can quickly and easily attach to a circuit board carrying a semiconductor device package.

It is a further object of the present invention to provide a heat sink assembly that can be hand-tightened to provide a custom tension between the heat sink member and the device to be cooled.

It is yet a further object of the present invention to provide a heat sink that can attach to and cool a heat generating surface.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features which are characteristic of the present invention are set forth in the appended claims. However, the invention's preferred embodiments, together with further objects and attendant advantages, will be best understood by reference to the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 is a perspective view of the heat sink assembly of the present invention installed on a heat generating device residing in a socket;

Fig. 2 is an exploded perspective view of the heat sink assembly shown in Fig. 1;

Fig. 3 is an exploded side view of the heat sink assembly shown in Fig. 1;

Fig. 4 is an assembled side view of the heat sink assembly shown in Fig. 1;

Fig. 5 is a top view of the heat sink assembly of Fig. 1 showing installation of the clasp plate;

Fig. 6 is a side elevational view of the heat sink assembly of Fig. 1 showing installation of the heat sink member;

Fig. 7 is a cross-sectional view through the line 7-7 of Fig. 1; and

Fig. 8 is a perspective view of the heat sink assembly of the present invention installed on a heat generating device affixed directly to a circuit board.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to Figs. 1-3, the preferred embodiment of the heat sink assembly 10 of the present invention is shown. A heat sink assembly 10 is installed on a heat generating device 12, such as a semiconductor package installed in a socket 14 connected to a circuit board 16. It should be noted that the present invention provides a heat sink assembly 10 for attachment to any heat generating device 12 with an array of holes 18 completely therethrough or partially therethrough. The present invention is shown in Figs. 1-7 as attaching to a surface mount semiconductor device package 12 in a socket 14 is for illustration purposes only. It should be understood that various other types of semiconductor packages 12 may be accommodated by the present invention. Fig. 8, as will be discussed in detail below, shows a further application to attach to a heat generating surface that is affixed directly to a circuit board 16 without the use of a socket 14.

Referring to Figs. 1-3, the heat sink assembly 10 of the present invention includes a backing plate 20 with an array of alignment pins 22, each with an engagement head 24 at the respective free ends. The alignment pins 22 may be fastened to the backing plate 20 in many different ways, such as soldering, molding, riveting or by threaded fastener (not shown). A clasp plate 26 is provided with an array of slits 28, which correspond with the alignment pins 22 on the backing plate 20, as well as a substantially located female threaded bore 30. A heat sink member 32 includes a male threaded shank 34 and heat dissipating members 36, such as radial fins as shown. Alternatively, other heat dissipating member configurations may be employed, such as a pin grid array (not shown).

Turning now to Figs. 4-7, the installation of the heat sink assembly 10 of the preferred embodiment of the present invention to

a heat generating device 12 is shown. In Fig. 4, the backing plate 20 is installed to the circuit board by routing of the alignment pins 22 through holes 17 in the circuit board 16 from below so that the heads 24 of the alignment pins 22 are exposed above the circuit board 16 and the heat generating device to be cooled. Also, the alignment pins 22 are routed through the corresponding holes 18 in the socket 14 carrying the device 12 to be cooled. In this preferred embodiment, the socket also includes holes 18 which correspond with holes 17 through the circuit board 16. However, some sockets carrying a device 12 to be cooled may not include through holes 18 but may be smaller in plan than the area defined by the alignment pins 22 thus obviating the need for holes 18 through the socket 14.

Turning now to Fig. 5, once the backing plate 20 is installed, the clasp plate 26 is installed by routing the alignment pins 22 through the slits 28 in the clasp plate 26. Such routing permits the heads 24 of the alignment pins 22 to enter into respective corresponding slits 28. The clasp plate 26 is then slid along the line of the slits 28 to cause the heads 24 of the alignment pins 22 to respectively travel into a narrowed portions 28a of each slit 28. The narrowed portion 28a of each slit 28 is only wide enough to permit the reduced neck portion 22a, as shown in Figs. 3 and 4, of an alignment pin 22 to enter. As a result, once the clasp plate 26 is slid horizontally, it cannot be vertically removed from the alignment pins 22.

As illustrated in Fig. 6, once the clasp plate 26 is in place, the heat sink member 32 is threaded into the female threaded bore 30 in the clasp plate 26. Such threading of the heat sink member 32 is preferably done by hand rotation of the user. Fig. 6 shows the heat sink assembly 10 in the process of threadably receiving the heat sink member 32. As can be seen, the clasp plate 26 is loosely routed on the alignment pins 22 and is limited in its vertical travel due to the engagement of the heads 24 of the alignment pins 24 and the slits 28 of the clasp plate 26. Fig. 7 shows the result of further threaded engagement of the heat sink assembly 10 with the bore 30 of the clasp plate 26. In Fig. 7, the bottom contact surface 33 of the shank 34 of the heat sink assembly 10 is in flush thermal communication with the top heat generating surface 13 of the device 12 to be cooled. Due to the downward threading of the heat sink member 32, the clasp plate 26 is now lifted up against the undersides of the heads 24 of the alignment pins 22, as shown by the arrows, thereby clamping the entire

assembly 10 in place on the heat generating device 12 to provide the necessary tension to maintain the electrical contacts of the heat generating device to the socket into which it is installed as well as sufficient tension to maintain good flush thermal communication to achieve proper heat dissipation. Most importantly, the present invention provides a heat sink assembly 10 with a single adjustable member 32 that provides an evenly distributed compression force to the top surface 13 of the device 12 to be cooled. This single adjustment avoids the difficult and time consuming problem of adjusting multiple compression members to achieve downward force to the device to be cooled. As a result, the present invention is easier to manufacture and install than prior art assemblies while achieving superior heat dissipation and electrical socket contact and being less expensive to manufacture.

Referring now to Fig. 8, an alternative application of the present invention 10 is shown. Figs. 1-7 illustrates the installation of the heat sink assembly 10 to a heat generating device 12 that is installed in a socket 14 that is connected to a circuit board 16. Fig. 8 shows the heat sink assembly 10 installed on a heat generating device 12 installed directly on a circuit board 16. In similar fashion to the application shown in Figs. 1-7, the alignment pins 22 are routed through the circuit board 16 to be received by the slits 28 in the clasp plate 26. The heat sink member 32 is threaded into the bore 30 and into the heat generating device 12 to provide tension for flush thermal communication between the heat sink member 32 and the heat generating device 12 for proper heat dissipation.

As will be readily apparent, the heat sink assembly of the present invention can accommodate a wide range of semiconductor arrangements where holes are provided proximal to the package or surface to be cooled. It should be understood that the provision of four legs and four corresponding receiving holes is by way of example only and that fewer or greater than four legs and corresponding receiving holes may be provided in accordance with the application at hand.

The present invention has a wide range of applications and can be easily adapted for such applications. Further applications include any circuit board configuration where a heat generating device is provided on a circuit board or similar substrate and where a receiving structure, such as an array of holes, are provided. The present invention may be easily adapted to an application where the circuit board containing the heat generating

device is encased in a housing, such as a Pentium II configuration (not shown).

It is preferred that the clasp plate 26 be manufactured of plastic material, such as a high temperature resistant and high creep resistant plastic for better withstanding the high temperatures associated with microprocessors. For example, the plastic material for the clasp plate 26 may be VERTON UF-700-10-HS (P.P.A. 50% long fiber), available from the LNP Corporation or ULTEM which is available from General Electric Company for use in high temperature heat sink applications. Alternatively, the clasp plate 26 may be manufactured of metal, such as aluminum, depending on the application. The backing plate 20 is also preferably made of plastic material but also may be made of metal. The configuration of the backing plate 20 is not critical other than providing the alignment pins 22 in a secure array. For example, the backing plate 20 may be solid or of a frame to reduce its weight. The alignment pins 22 are preferably made of metal material.

In addition, the heat sink member 32 is preferably metal, such as aluminum, for optimum thermal transfer and dissipation of heat from heat generating devices 12. Alternatively, the heat sink member 32 may be made of a thermally conductive plastic material to suit the application. Also, fins 36 are provided in a radial configuration but various other heat sink fin configurations, such as a pin grid array, may be employed.

It should be understood that all of the threaded components of the present invention may include various types of threads which are envisioned and are deemed to be within the scope of the present invention. These various thread designs include continuous and interrupted threads. It is preferred that there be at least more than one turn to facilitate the adjustment of pressure. However, a single turn 360° thread, as well as half and quarter turn thread are considered to be within the scope of the present invention due to the ability to impart any desired pressure. Further, bayonet-type attachment methods, which engage with ramped notches within a bore, are also considered to be threads which can provide a gradual, hand-controllable pressure in accordance with the present invention.

It would be appreciated by those skilled in the art that various changes and modifications can be made to the illustrated embodiments without departing from the spirit of the present invention. All such modifications and changes are intended to be covered by the appended claims.

WHAT IS CLAIMED IS:

1. A heat sink assembly for removing heat from an electronic device having a heat generating surface and a plurality of mounting holes therein, comprising:

a backing plate having alignment pins extending therefrom, said backing plate disposed adjacent to a bottom surface of a printed circuit board, carrying a heat generating device with a heat generating surface surface, having first holes formed therethrough receiving said alignment pins;

a clasp plate disposed adjacent to a top surface of a printed circuit board having slits formed therethrough, said slits grasping said alignment pins; said clasp plate further including a female threaded bore therethrough and positioned over said heat generating device;

a heat sink member having heat dissipating members and a male threaded shank with a bottom contact surface; said male threaded shank being threadably engageable with said female threaded bore so that said bottom contact surface of said threaded shank is maintained in flush thermal and tensioned communication with said heat generating surface of said heat generating device.

2. The heat sink assembly of Claim 1, wherein each of said alignment pins include a reduce neck portion and each of said slits in said clasp plate include an enlarged aperture portion to vertically lock said clasp plate relative to said backing plate upon horizontal sliding of said clasp plate on said alignment pins.

3. The heat sink assembly of Claim 1, wherein said heat dissipating members of heat sink member are radial fins.

4. The heat sink assembly of Claim 1, wherein said heat dissipating members of heat sink member are a pin grid array.

5. The heat sink assembly of Claim 1, wherein said heat sink member is made of metal.

6. The heat sink assembly of Claim 1, wherein said heat sink member is made of thermally conductive plastic.

7. The heat sink assembly of Claim 1, wherein said clasp plate is made of metal.

8. The heat sink assembly of Claim 1, wherein said clasp plate is made of plastic.

9. The heat sink assembly of Claim 1, wherein the size of said female threaded bore is substantially equal to the area of said heat generating surface.

10. A heat sink assembly for removing heat from an electronic device having a heat generating surface and a plurality of mounting holes therein, comprising:

a printed circuit board having a top surface and a bottom surface and holes formed therethrough;

a socket disposed on said circuit board;

a heat generating device installed in said socket; said heat generating device having a heat generating top surface;

a backing plate having alignment pins extending therefrom, said backing plate disposed adjacent to said bottom surface of said printed circuit board; said holes of said printed circuit board receiving said alignment pins;

a clasp plate disposed adjacent to said top surface of said printed circuit board and having slits formed therethrough, said slits grasping said alignment pins; said clasp plate further including a female threaded bore therethrough and positioned over said heat generating device;

a heat sink member having heat dissipating members and a male threaded shank with a bottom contact surface; said male threaded shank being threadably engageable with said female threaded bore so that said bottom contact surface of said threaded shank is maintained in flush thermal and tensioned communication with said heat generating surface of said heat generating device.

11. The heat sink assembly of Claim 10, wherein each of said alignment pins include a reduce neck portion and each of said slits in said clasp plate include an enlarged aperture portion to vertically lock said clasp plate relative to said backing plate upon horizontal sliding of said clasp plate on said alignment pins.

12. The heat sink assembly of Claim 10, wherein said heat dissipating members of heat sink member are radial fins.

13. The heat sink assembly of Claim 10, wherein said heat dissipating members of heat sink member are a pin grid array.

14. The heat sink assembly of Claim 10, wherein said heat sink member is made of metal.

15. The heat sink assembly of Claim 10, wherein said heat sink member is made of thermally conductive plastic.

16. The heat sink assembly of Claim 10, wherein said clasp plate is made of metal.

17. The heat sink assembly of Claim 10, wherein said clasp plate is made of plastic.

18. The heat sink assembly of Claim 10, wherein the size of said female threaded bore is substantially equal to the area of said heat generating surface.

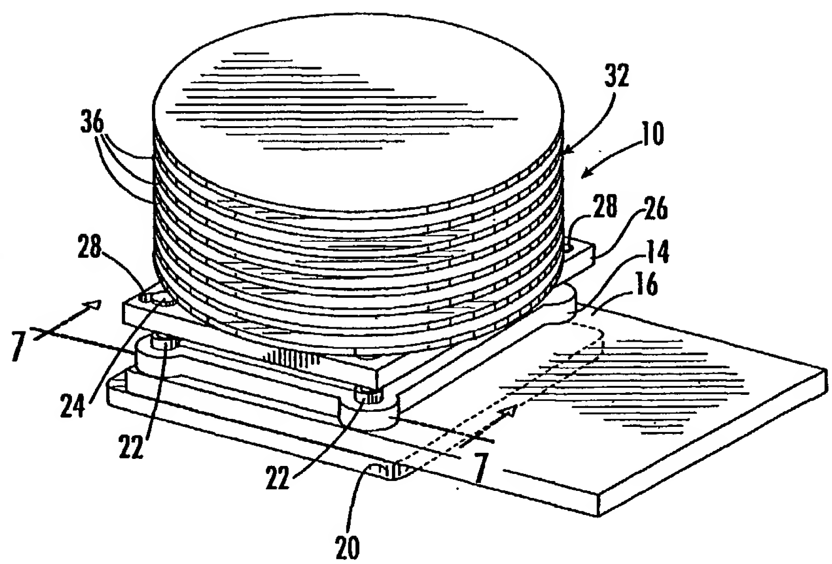

FIG. 1.

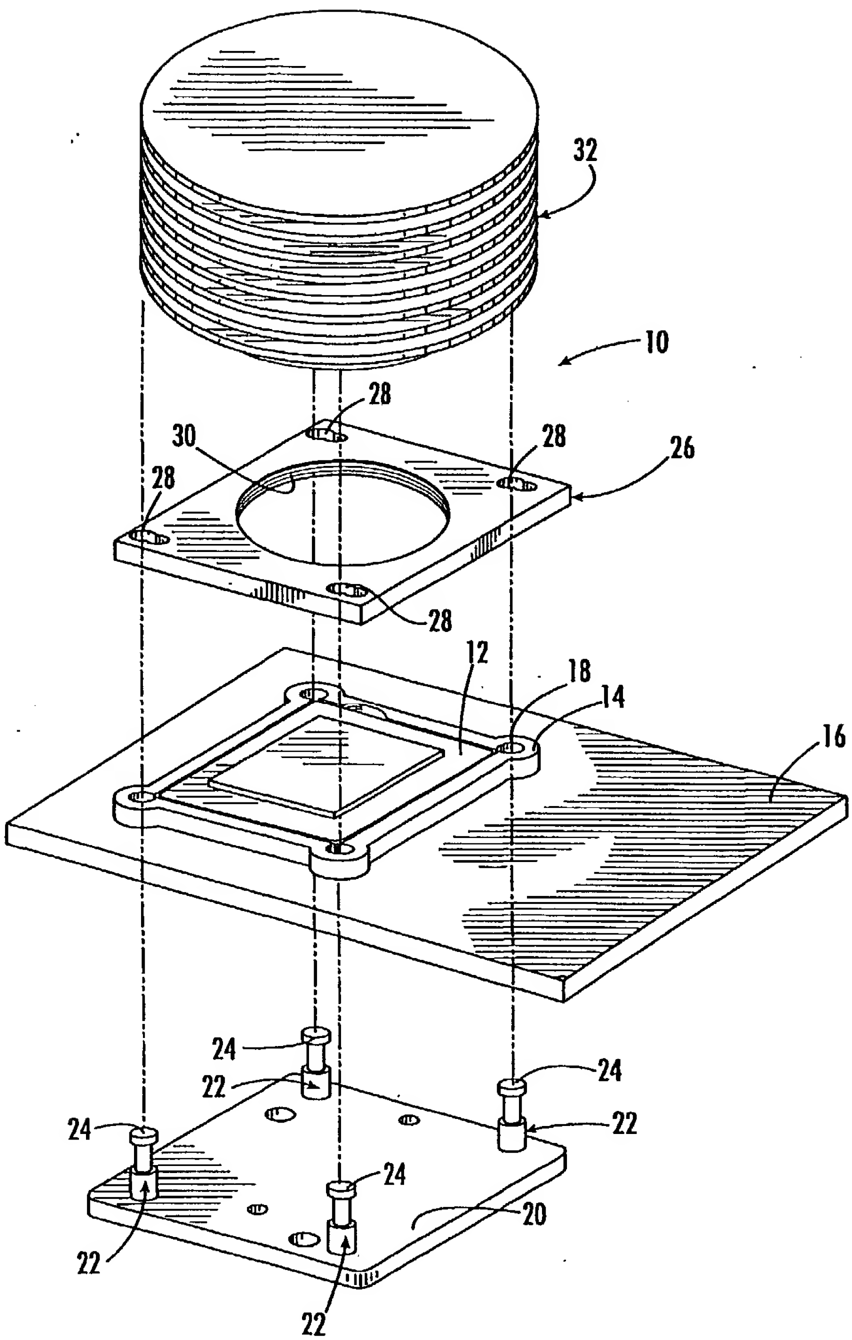

FIG. 2.

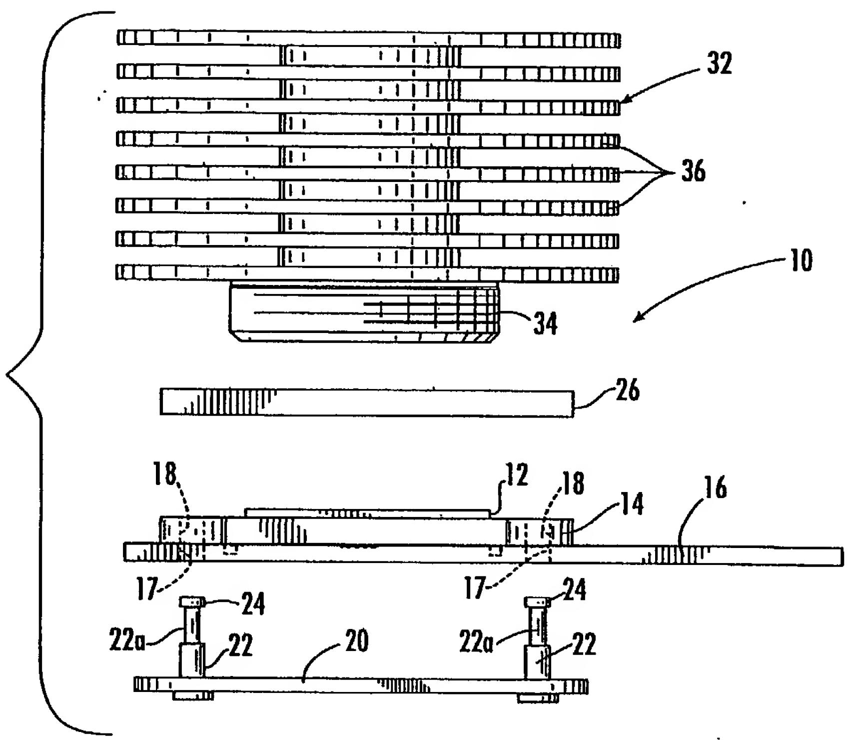
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FIG. 3.

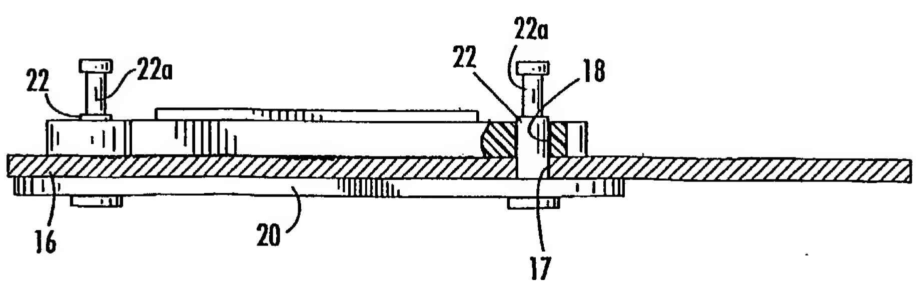
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FIG. 4.

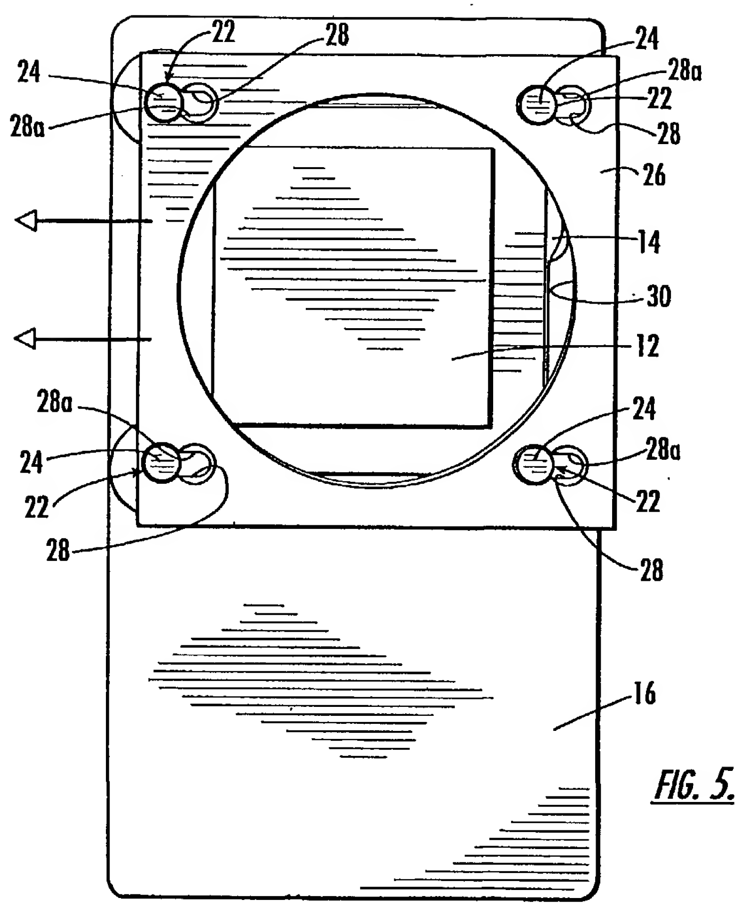
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FIG. 5.

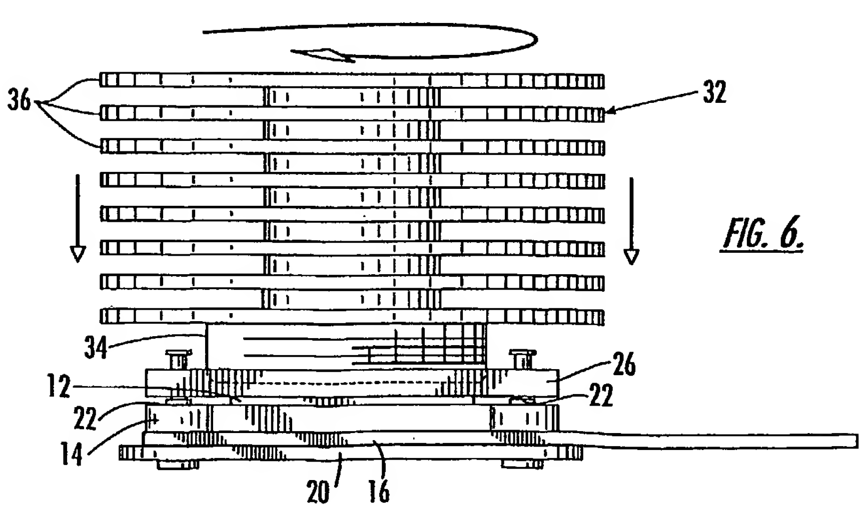
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FIG. 6.

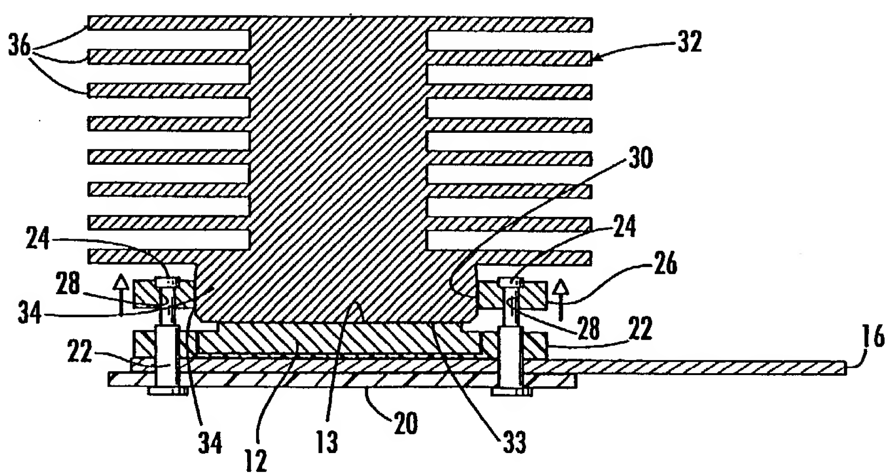

FIG. 7.

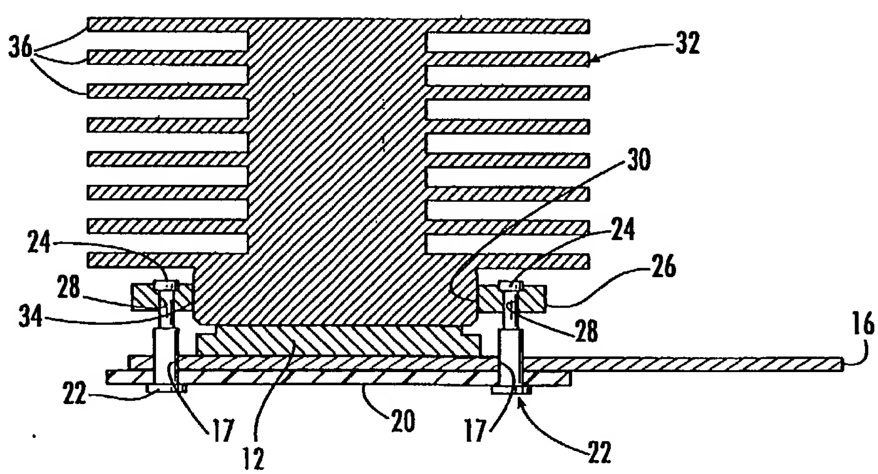

FIG. 8.